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**Final Performance Report:
Digital Dialectic: Forging New Paths of Inquiry in the Humanities**

White Paper to the NEH Office of Digital Humanities
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ABSTRACT

Digital Dialectic is a project to digitize an immersive mural, *Mundos de Mestizaje*, as a starting point for the development of accessible, interactive, technology-based resources for a variety of artifacts. The ultimate goal of Digital Dialectic is to spark deeper contextual exploration and understanding of cultural artifacts and illuminate the multicultural and multi-disciplinary nature of the humanities. Digital Dialectic is a partnership between the National Hispanic Cultural Center (NHCC), a division of NM Department of Cultural Affairs, in Albuquerque, NM and the ARTS Lab at the University of New Mexico. *Mundos de Mestizaje*, a *buon fresco* mural by Frederico Vigil, allegorically depicts thousands of years of Hispanic history and cross-cultural exchange of ideas through more than 125 visual and historical references painted on 4000 square feet of interior wall space in the Torreón (tower) on the 31-acre campus of the NHCC. The NHCC and ARTS Lab created a digital gigapixel panoramic photographic version of the *Mundos de Mestizaje* mural which is high-resolution, three-dimensional, and scalable. This digitization lays a solid foundation for a long-term, interactive, technology-based, multi-platform, innovative, outreach plan to engage and educate diverse audiences directly with this permanent, immersive work of art far beyond the walls of the Torreón in classrooms, universities, theatres and other cultural institutions. As a result of this NEH grant, the digitized version of the mural is complete and is currently paired with an interactive software application and web-based viewer that allows users to explore the mural along with educational, humanities-based content embedded in the imagery. The digitized mural can also be presented and viewed through an immersive dome projection which allows widespread audiences to view the mural at actual scale and explore details with high-resolution magnification.

INTRODUCTION

Humanities educators need accessible, innovative technological tools that invite students of all ages to explore and discover the dynamic, interdisciplinary nature of the humanities. As a result of the Digital Dialectic project, project partners at the National Hispanic Cultural Center and UNM ARTS LAB were able to create a visual portal for multiple levels of discourse which can serve educators, students, and the general public as pursue self-guided discoveries of the context and history surrounding the *Mundos de Mestizaje* mural which has multiple layers of humanities content. This project capitalized on the representational imagery in the mural as non-linear entry-points into the complex history of Hispanic identity in Europe and the Americas. By taking advantage of emerging technologies and new software applications, the resulting resource illustrates the connectedness of the humanities and meets the demands of 21st Century learners by engaging audiences through layered content and individual exploration in immersive and interactive experiences.

This phase of the Digital Dialectic project focused on creating more public access to one physical artifact which had several characteristics that made it challenging to share widely with the public: the enormous scale of the mural, the complete lack of mobility and the many layers of content and meaning. Digital Dialectic project staff responded with high quality, innovative, interactive, digital solutions to challenges presented by the large mural. As a result, Digital Dialectic project significantly increased the opportunity for meaningful public access to the artifact as well as access to historic, artistic, and cultural context and content of the mural.

Large scale, detailed artwork and artifacts like the *Mundos de Mestizaje* mural are difficult to view extensively and study, even when visited in person. The scale and 40' elevation of the artwork make it difficult to absorb fully or to view detail closely. Furthermore, online viewing of a complete photographic view is not possible without a highly distorted fish-eye lens. Extreme resolution, high-dynamic range panoramic photography, navigated through an interactive viewing program offers users access to details and content that are otherwise inaccessible. In addition to the challenges of scale involved in viewing works like this large-scale mural, it is also critical that public institutions begin to pursue more and more technology-based solutions that provide public access to artifacts of all sizes so that public access is not limited to patrons, students, and public that have the ability to physically travel to visit the artifact. The outcomes of this Digital Dialectic project are relevant not only to large-scale, physically immobile artifacts, but also to fragile artifacts, artifacts in sites with restricted access, historic sites or buildings in remote locations and collections of artifacts with limited exhibition space.

GOALS, STATED AND ADJUSTED

The stated goals of the proposal were not adjusted. The stated and achieved goals were as follows:

1. Create a **high resolution, panoramic digital photograph** of the *Mundos de Mestizaje* mural.
2. Create a **composite, geometrically correct, seamless, high-dynamic range rendering of the digital image** to serve as a multi-purpose visual asset for a variety of interactive, educational and outreach resources
3. Design and implement an **interactive panoramic viewing software and website** that demonstrates the quality of high resolution image capture, ability of users to virtually fly through the mural from perspectives impossible on-site (zooming into images on the 40' high ceiling, for example), as well as seamless interactive capabilities between the mural imagery and educational content.
4. Develop **curriculum and lessons plans** to accompany the interactive viewing and website for elementary, middle and high school students.
5. Design and develop an **interactive, full-dome piece** using the visual asset of the *Mundos de*

Mestizaje mural to allow audiences to virtually fly through the imagery at scale and explore content.

IMPLEMENTATION

The project was successfully completed within the project period and under budget. Additional opportunities that manifested through the process were also exploited, adding both new features and new findings to the project's results. The interactive version of the mural and supporting educational materials are online now at <http://mundos.nationalhispaniccenter.org> [Figure 1]. The website is under final *in situ* testing and internal approvals before publicizing and publishing the link in January 2014.



Figure 1: *Mundos de Mestizaje* website home page

As proposed, the NHCC and ARTS Lab staff worked as a team throughout the duration of the project, with quarterly meetings for the entire. Subgroups of project staff met monthly or weekly to focus on individual components of the project such as photography and digitization, website design, full-dome media, lesson plan development, content research and development, and evaluation.

The first technical task was image capture of the mural which began in June 2012 and continued into Fall 2012. There were many foreseen challenges of photographing the mural: the unusual architecture of the Torreón, the inflexible lighting of the space and the impact of the natural light from the sky light, and the sheer size (40' tall and 4000 square feet of curved walls). Even with foresight, the photography was still a major challenge and required more time than anticipated.

Regular meetings and research for the embedded content and curriculum began in June 2012 and continued through August 2013 with research, writing, evaluation, feedback loops through several iterations of all content for website and for lesson plans. Although all content development work was completed within project timeframe, each task required substantially more time than projected in the original proposal, primarily due to the fact that project staff came from different institutions so other competing priorities often shifted meeting dates and timelines for one or more person on the task.

The creation of the base visual asset required stitching together individual images of the mural. Once the base visual asset was complete, ARTS Lab staff and students developed interactive components for on-line viewing and individual navigation. A variety of software solutions were attempted and more appropriate, robust software applications emerged during the course of the project. Most or all relevant challenges were foreseen, but completion times required more time than allotted in proposed timelines.

Beginning in early 2013, NHCC staff and interns in partnership with ARTS Lab staff and students designed and implemented a website that now houses the products of this project and makes the current iterations of the interactive, embedded content and curriculum accessible to the general public.

The ARTS Lab staff spent significant time developing the immersive media component for use in full-dome theaters in both recorded (playback) and interactive ways. The interactive version is a 3D, real-time model that allows viewers to “fly through” by the navigation of a full-dome operator.

Evaluation

Project staff reviewed and refined all components of the project based on internal and external evaluations at various points of the project. Project staff evaluated summary content, interactive assets and immersive components. Additional details about evaluation activities are included in the Appendix.

Visitors. At the beginning of the project, NHCC staff distributed surveys to visitors at the mural at the NHCC; 172 surveys were returned from a mix of students, educators, and general visitors. The written survey asked visitors to share what information about the mural (background, artistic process, historical/cultural content, facts, etc.) interested them most and to share how visitors were most interested in receiving that information. The survey results revealed that visitors’ priorities were: information on the mural as an art form, specific content/facts related to the images in the mural, and history related to the imagery. Responses to the survey prioritized online resources, videos and a gallery guide as methods for receiving the information.

Dialogue participants. In partnership with the International Coalition of Sites of Conscience, NHCC staff conducted evaluation for twelve facilitated dialogue sessions based on the mural imagery. NHCC staff collected evaluations from dialogue participants and designated observers. These evaluations revealed favorable appreciation for the dialogue sessions, the content and the mural.

Teachers. Once the mural interactive was complete, NHCC and ARTS Lab staff invited a group of K-12 teachers to attend an evaluation session at ARTS Lab to review the lesson plans in direct association with the online interactive. During the evaluation session, project staff used dome projection of the mural in place of viewing the actual artwork.

UNM Faculty and Staff. Throughout the project, ARTS Lab staff recruited students, staff and faculty at UNM to test the beta-level software and website for functionality and interface assessment. ARTS LAB staff also presented draft work to small audiences in the Lab’s research dome as part of its’ ongoing evaluation of the functionality of the products. Beta testers’ feedback informed revisions in both the online interactive and the experiments in the full-dome productions. Additionally, Lab staff presented draft full-dome works of the mural at *DomeFest 2012* in Baton Rouge to gather critical and evaluative feedback from the attending international group (about 250) full-dome professionals.

Audiences

The audiences included in the development of the project were museum visitors, museum volunteers, educators, students (ages 12 to 25), museum professionals, university faculty, staff and students and digital professionals. Digital Dialectic is meant for a large global audience between the ages of 8 and 80 years with a wide range of interests. Audiences can interpret the value of their experience on many levels. The overlay of content within the interactive addresses interests in history, geography, literature, mythology, migration, arts, sciences, architecture, philosophy, and religion with an over-arching connection to cultural layering.

OUTCOMES AND ACCOMPLISHMENTS

1. High Resolution, Panoramic Digital Photography of *Mundos de Mestizaje* for Composite Rendering

ARTS Lab staff photographed the mural using a Canon 5D MkII camera at full (21 Megapixel) resolution and RAW codec with a 24mm/F2.4 Canon L2 lens. The camera was attached to a robotic telescope mount/driver that was converted for panoramic photography. The mount and camera were controlled over Bluetooth via open-source software modified by ARTS Lab and run off a circa1999 'personal digital assistant.' [Figure 2]



Figure 2: Robotic Panorama Rig

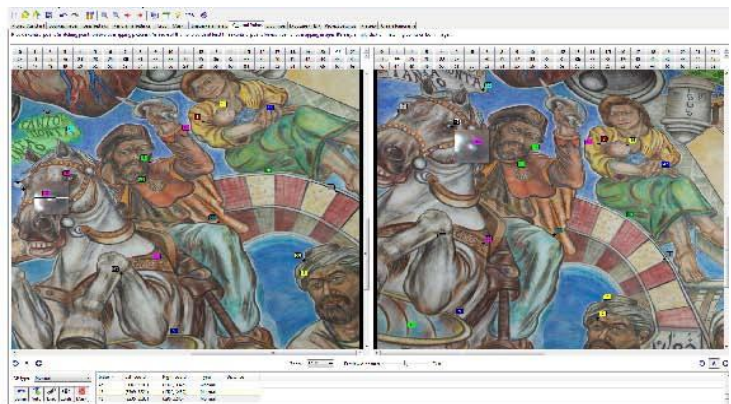


Figure 3: Image Stitching Process

More than 3 billion pixels were created for the panoramic image, with a high dynamic range technique in which each portion of the mural was recorded three times at different (+1, 0, -1) exposure values to capture additional information about the bright and dark regions of the art. The photographs were stitched and geometrically adjusted to an equirectangular projection of the 360x180 degree field of

view using PTGUI [Figure 3] and post-processed in Photoshop for a resulting image measuring 24,000x12,000 pixels (288 Megapixel) that was used in the interactive [Figure 4]. The resolution was limited in a compromise between users' potential bandwidth limits and the ability to resolve some of the artists' brushstrokes.



Figure 4: Post-processed image (flattened) of mural

2. Interactive Panoramic Viewing Software and Website Design and Development.

ARTS Lab and the NHCC staff created a website and supporting software to enable users to access the quality of high-resolution image capture and to virtually fly through the *Torreón* to view the mural from perspectives impossible on-site, such as zooming into images on the 40' high ceiling. ARTS Lab researched commercial and open-source solutions and prototyped several experimental frameworks for depicting and rendering the mural in an online experience. The research found a commercial (boutique) framework that met the project's needs, KR pano. The software served as the basis for the online experience with Lab staff writing more than 10,000 lines of code to support the user interaction and embedded content. The resulting viewing software and website present a seamless interactive capability between the mural imagery and educational content which is embedded throughout the digital version of the mural. This website will be available for public access beginning in January 2014, and will remain a permanent key feature in NHCC's website and online resources for educators, students, artists, and the general public.

3. Summary Content of Key Imagery in English and Spanish

During the start-up phase of project development, NHCC staff, interns, and volunteers researched Prioritized list of 73 individual visual references from the mural (from a total of more than 150 visual references). For each of these seventy-three images, project staff wrote: (a) descriptive titles, (b) short (10 – 20 words) descriptions of historical significance of the image, and (c) an expanded description of each image (20 – 30 additional words). This same summary content for each image was professionally translated into Spanish. This summary content is embedded in the digital interactive of the mural and

available on the website [Figure 5].

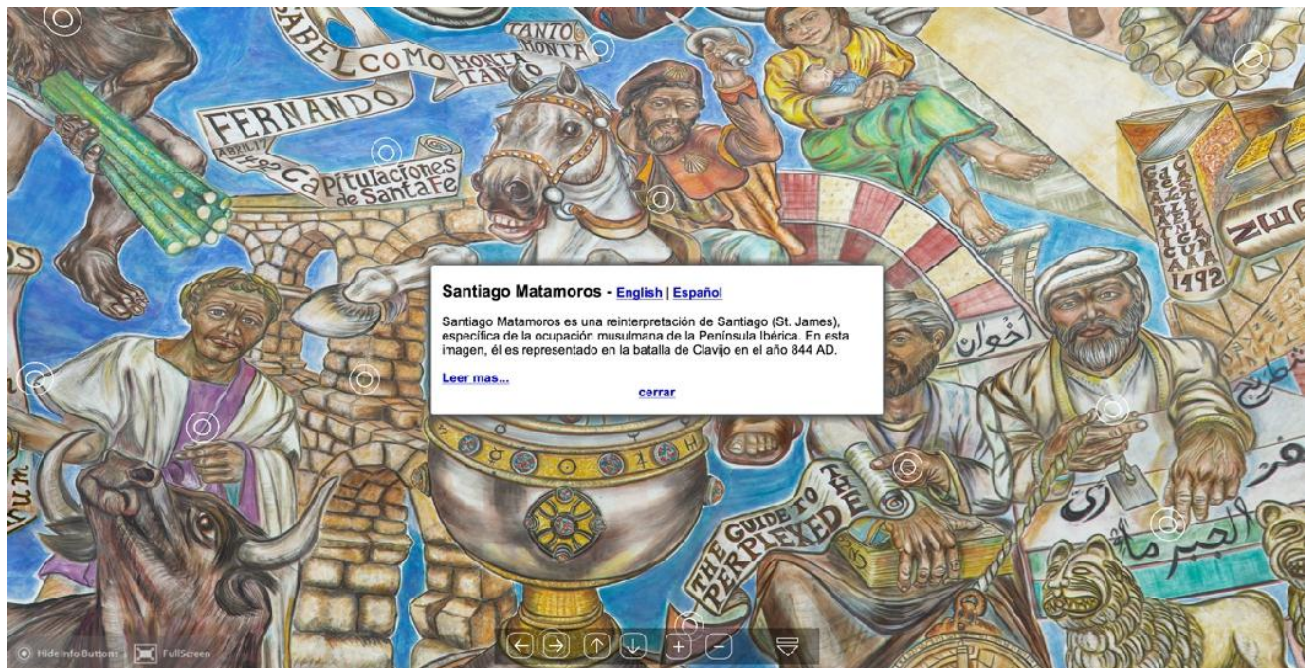


Figure 5: Summary content embedded in the digital interactive

4. Supporting Curriculum and Lesson Plans

The curriculum and lessons plans were developed by Dr. Rebecca Sanchez, Professor in the College of Education, University of New Mexico, in partnership with NHCC Education staff. The outcome is a series of Humanities-based lessons grounded in the content of the mural and included on the website. This resource encourages teachers and students to explore of cultural, artistic, religious, linguistic, political, and economic exchange. The curriculum examines how cultural exchange and *mestizaje* (mixing of peoples and cultures) manifest at regional and global levels. Currently, the curriculum includes units for elementary school, middle school, and high school. Each unit contains five lessons with an overview for the teacher, supplemental materials, Standards and Benchmarks, Common Core requirements and suggested materials where appropriate. Each unit includes three lesson plans that use the web-based digital interactive in the classroom, one art-based lesson plan incorporating a creative writing component, and one onsite lesson plan for students who are able to visit the mural at the NHCC campus.

6. Design and Development of Full-dome Piece.

ARTS Lab produced a full-dome projection of the mural utilizing the same digital assets that support the website. The dome piece has interactive capabilities that allow audiences to virtually fly through the imagery at scales closer to actual size. In the ARTS Lab's research dome, the scale is limited to a 4-meter diameter dome, but at *DomeFest 2012* in the Louisiana Museum of Art & Science's dome (about 17M) the scale was at about 120% of the actual mural. The mural was produced and presented via three different techniques. First, using the dome's realtime system, the equirectangular image was distorted to a equidistant azimuthal fisheye. This version allowed the interactive viewing of 360x180 degrees with a virtual camera that could pan and tilt to move the mural for the audience, but did not allow any 'zoom' into the art's detail and showed a distortion effect most noticeable near the Torreón's ceiling. Second, the equirectangular image was converted to a cylindrical image cropped to show only the vertical walls of the

fresco (about 360x120 degrees). The cylindrical image was mapped to a cylindrical primitive in the dome's real-time system and the digital cylinder was “pulled over” the audience and allowed for close-up views. This version had improved geometry but was missing the ceiling art. The third version was a pre-rendered movie created in AfterEffects using the same equirectangular image produced for the interactive. The Lab employed a distortion technique created by partners at the Navegar Foundation (Portugal) and the results were largely successful in terms of geometric corrections, the camera's motions (pan, tilt and zoom) and was the preferred technique by the majority of viewers. [Figure 10.]

7. Video and Audio Tours.

The project staff began work on video and audio content which can be embedded in the mural interactive. Initial projects include an overview of the history of New Mexico based on the imagery of the mural and an audio segment for younger audiences on the origins of the tomato.

8. Printed Image Resource Handbook.

The *Mundos de Mestizaje: Images Handbook 2013 v. 1* was created based on the Summary Content of Key Imagery and distributed to the NHCC Docents to support their onsite tours and support them as they use the interactive, web-based resource. The Images Handbook will also serve as a foundation for a larger gallery guide or book for visitors to the *Mundos de Mestizaje* mural.

9. Presentations, Partnerships, and Conferences.

NHCC and ARTS Lab staff promoted and presented the project through other partnerships and conferences attended by project staff. The NHCC staff shared content at the *Museums and the Web 2012* conference in San Diego in 2012. The NHCC uses the mural as the foundation of dialogue work it is building in partnership with International Coalition of Sites of Conscience. This long-term partnership provided three distinct opportunities the NHCC to share about the development of content and the high resolution interactive with museum colleagues and cultural professionals from across the country. In September 2013, NHCC staff presented its' Immigration Dialogue along with the *Digital Dialectic* interactive at the *American Association for State and Local History (AASLH) 2013* conference in Birmingham, Alabama. The NHCC continues to work with International Coalition of Sites of Conscience on a the NEH and IMLS funded project: *National Dialogues on Immigration*, devoted to implementing dialogue programming around the issue of immigration. The focus of the NHCC programming in this effort uses the imagery of the mural and the long history of immigration and migration to tie into the importance and relevancy of immigration issues today. The NHCC has conducted a dozen immigration dialogues onsite and offsite including the use of the digital interactive of the mural.

ARTS Lab presented the outcomes of Digital Dialectic and shared the digital asset at different stages of research and development) at several professional and academic conferences. These conferences include: *DomeFest 2012*, an international fulldome festival and conference produced by ARTS Lab. *DomeFest 2012* was co-hosted by the Louisiana Museum of Art & Science (Baton Rouge) in July 2012. The work was also featured in a review of Lab research projects at the Immersive Media Education, Research, Science and Art Association's annual meeting at the Denver Museum of Nature & Science in February 2013. In November 2013, ARTS Lab director, Tim Castillo, presented the penultimate version of the interactive at the International Digital Media Association Conference in California.

NEXT STEPS

The NHCC and the NM Department of Cultural Affairs are developing plans to further the *Digital Dialectic* project through development of interactive, technology-based resources associated with the *Mundos de Mestizaje* mural along with the application of the same photographic and software processes to other large-scale cultural artifacts and/or historic sites.

Onsite interactive. Initially, the NHCC planned to install touch-screen kiosk in the *Torreón* to allow visitors to access the interactive website and layered content in the presence of the mural. However, as the technology and accessibility of interactive and hand-held personal devices are evolving quickly, there are many options to explore and consider in the next phase in order to create an interactive experience and provide access to layers of information alongside the artwork itself. These options include: smart phone and tablet applications employing image-recognition and/or accelerometer/gyroscope/compass-based interactions as well as other potential cutting-edge platforms that may still be in development. Example technologies to be investigated include: WebGL, GPU-sharing systems such as Syphon, as well as new development in light-transport and rendering techniques.

Traveling projection exhibition. ARTS Lab and the NHCC plan to engage additional partners with dome projection capability to create a traveling projection exhibition of the mural. During the next phase, project staff will investigate emerging options for sharing a large-format immersive piece beyond the full-dome venue. Recent technical innovations provide immersive projection mapping techniques for diverse surfaces (i.e. corners of classrooms or galleries rather than full-dome theatres) which can further the development of the interactive immersive experience with more embedded humanities content broadening the dissemination range to other cultural institutions.

Curriculum expansion. The NHCC plans to develop additional curriculum to explore the contemporary issue of immigration, contemporary reflections of identity that confront many *hispanos* born in the U.S. in relationship to the imagery depicted in the mural along with deeper exploration into wealth of history, arts and literature content of the mural.

Other artifacts, sites, and technical applications. Finally, next project phases will include an exploration of how this technology and planning prototype can be applied in other institutions and for other art works or cultural artifacts with the Department of Cultural Affairs or other museums. ARTS Lab also hopes to engage a member of the Google team (a former UNM associate professor of computer science) to specifically consider and contribute to the projection mapping for traveling projection exhibition.

ACKNOWLEDGEMENTS

The Digital Dialectic project has been a true, functioning and successful partnership among several groups of talented and dedicated individuals and their supporting organizations: the Education staff at the National Hispanic Cultural Center, a division of the New Mexico Department of Cultural Affairs; staff and faculty of the ARTS Lab at the University of New Mexico; faculty in the College of Education at the University of New Mexico; and volunteers committed to preserving and promoting history and the culture of New Mexico. The interdisciplinary skills, diverse interests, and capacity for teamwork of the project staff resulted in the quality of the final products.

APPENDIX

A. PRODUCT

The interactive version of the mural, visual asset, and supporting educational materials are online <http://mundos.nationalhispaniccenter.org>

B. PROJECT TEAM BIOGRAPHIES

Shelle VanEtten de Sanchez, Ph.D. is the Digital Dialectic Project Director. She has worked for the New Mexico Department of Cultural Affairs since January 2002, currently serving as the Director of Strategic Initiatives. She holds a B.A. in Spanish and French, and an M.A. and Ph.D. in Education. Her professional background spans 25+ years of diverse experience that includes arts and museum education, classroom teaching, university instruction and research, distance education, community programs, and project management. She is committed to promoting arts, culture and creativity with special attention to collaborative programs, community connections, and lifelong education.

David Beining is the Digital Dialectic Technical Director, and serves as the Associate Director for Immersive Media at the UNM's ARTS Lab has directed educational and research initiatives in new immersive media tools, techniques and experiences since 2007. Beining is also the founder and Executive Director of 'DomeFest,' the first and largest global conference dedicated to digital dome theaters. Beining co-developed and delivered UNM's first interdisciplinary immersive media course with ARTS Lab director, Prof. Tim Castillo. He is currently a senior investigator on the NSF Partnerships for Innovation grant "A Consortium for Fulldome and Immersive Technology Development" (2010-12). Beining also served as the founding director of LodeStar Astronomy Center (funded by AFSOR) at the New Mexico Museum of Natural History & Science where he led the development of one of the world's first digital dome theaters (1999) – and directed some of the first immersive STEM films.

Erica Garcia is the Grant Administrator for Digital Dialectic and currently serves as the NHCC Curriculum and Community Coordinator. Garcia holds a BA in Spanish and Latin American Studies. Previously, she served the New Mexico History Museum/Palace of the Governors (NMHM) as Chief of Education (2004-2010). She was a member of the museum's Content Exhibition Development team for the construction and content of the permanent exhibitions for the NMHM. At NMHM she was charged with the production of curriculum and lesson plans including *Through the Lens*, *El Favor de los Santos*, *Lasting Impressions*, *Tesoros de Devoción*, and *Hilo de la Memoria*, online exhibitions including *Tesoros de Devoción*, *Hilo de la Memoria* and educational content for *Lasting Impressions* as well as interactives including the *Treaty of Guadalupe Hidalgo*, *Shifting Boundaries*, and *Hilo de la Memoria* for both exhibitions and websites. Garcia also worked for the Commission of Public Records and State Archives.

Rebecca Sanchez, Ph.D. is the Curriculum Specialist for Digital Dialectic. Dr. Sanchez is an Associate

Professor in the Department of Teacher Education at the University of New Mexico. She teaches courses in Social Studies Education, Social Justice Education, and Curriculum Development. She is author of numerous articles and book chapters related to social studies and history education including: "Listening to the locals, listening to the land"; and "Community as a Participatory Foundation in Social Studies Classrooms." She is currently working as Project Director on the NEH funded Landmarks of American History and Culture grant. The workshop is titled, "Contested Homelands: Knowledge, History, and Culture of Historic Santa Fe." She seeks to expose students and teachers to both the place-based social studies of New Mexico and the history that is overlooked in the national narrative of American history.

Chris Clavio, is an Electronic Artist and Entrepreneur currently pursuing a Bachelor's Degree in Fine Arts at the University of New Mexico. His work uses technology to emphasize the interconnectedness of human beings across the globe using light, sound, and interactive environments. His business, ClaviOn Unlimited LLC, is a platform which he uses to create digital media and interactive content in alignment with his artwork. Clavio has shown work across the United States, most recently in an exhibition at the John Sommers Gallery at the University of New Mexico. He has produced work for the Electric Forest Music Festival in Rothbury, MI as well as many shows in Albuquerque, NM. His current projects integrate several software platforms and various hardware configurations to create immersive and interactive environments that stimulate the senses. His most recent work, Facebook Mosaic, is a platform that pulls a user's Facebook data and uses it to generate digital paintings.

Miranda Viscoli received a B.F.A. at New York University as well as a B.A. from California State University at Long Beach. In the summer of 2009 she completed her M.A. in Latin American art history at California State University Long Beach. Her thesis, *The Revolution of Maria Izquierdo: Constructs of Gender and Nation in the Artist's Female Figures*, won the Outstanding Thesis Award for the College of the Arts. She was recently chosen to present her research at the Los Angeles County Museum of Art (LACMA) for the second triennial of ALAA. Ms. Viscoli's Ph.D. work will focus on Latin American Art with her dissertation continuing her exploration of Maria Izquierdo and the social constructs that help define both the artist and her art.

